Answer Key *(continued)*

Practice Problems From Page 17

D = 1.75 meters S = 1.32 mps T = 1.33 seconds	D = 2155 meters S = 57.5 mps T = 37.5 seconds	D = 14887.5 meters D = 14.9 kmeters S = 75 mps T = 198.5 seconds
D = 62.7 meters S = 253 mps T = .248 sec T = 248 msec	D = 12.34 meters S = 455014.75 mps S = 455 kmps T = 27.12 µsec	D = .22185 meters D = 222 millimeters S = 100 mps T = 2218.5 µsec
D = 8.88 meters S = .250 mps T = 35.52 sec T = 35520 msec	D = 2.47 meters S = 796.8 mps S = 797,000 millimps T = 3.1 msec	D = 39.5 meters D = .040 kmeters S = 12.25 mps T = 3222 msec

Answer Key *(continued)*

Practice Problems From Page 15

P = $ 500 H = 40 hours W = $ 12.50	P = $ 432 H = 32 hours W = $ 13.50	P = $ 437 H = 38 hours W = $ 11.50
P = $ 213.75 H = 28.5 hours W = $ 7.50	P = $ 231 H = 42 hours W = $ 5.50	P = $ 220.58 H = 51.9 hours W = $ 4.25
P = $ 415.19 H = 22.75 hours W = $ 18.25	P = $ 198.88 H = 21.5 hours W = $ 9.25	P = $ 152.08 H = 19.25 hours W = $ 7.90

Practice Problems From Page 16

D = 1750 miles S = 55 mph T = 31.8 hours	D = 2309 miles S = 61.6 mph T = 37.5 hours	D = 1237.5 miles S = 66 mph T = 18.75 hours
D = 627 miles S = 22.25 mph T = 28.2 hours	D = 1234 miles S = 45.5 mph T = 27.12 hours	D = 888 miles S = 48 mph T = 18.5 hours
D = 888 miles S = 88.8 mph T = 10 hours	D = 247 miles S = 79.7 mph T = 3.1 hours	D = 2304 miles S = 72 mph T = 32 hours

Answer Key *(continued)*

Review Problems From Page 11

Convert the quantities listed below.

Example:

	1000 milliseconds =	1	second
a.	30 milliliters =	.030	liters
b.	3800 meters =	3.8	kilometers
c.	490 microseconds =	.00049	seconds
d.	7.5 grams =	7500	milligrams
e.	.55 kilometers =	550	meters
f.	2.88 liters =	2880	milliliters
g.	4567 nanoseconds =	4.567	microseconds
h.	3.42 millimeters =	.00342	meters
i.	9876 milligrams =	9.876	grams
j.	6.25 seconds =	6,250,000	microseconds

Review Problems From Page 14

Calculate the answer for the two problems below, and round the answer to 3 digits.

1. 125 µsec x .98 sec = .123 milliseconds
2. 18.5 milligrams + .144 grams = 163 milligrams

(continued)

Review Problems From Page 10

2. Convert the following powers of 10 to conventional numbers.

Example:

	6.8×10^3	6800
a.	9.9×10^3	9,900
b.	10^5	100,000
c.	3.64×10^2	364
d.	10^{-4}	.0001
e.	2.81×10^{-3}	.00281
f.	6.3×10^{-4}	.00063
g.	65.1×10^{-6}	.0000651
h.	3×10^3	3000
i.	2.5×10^9	2,500,000,000
j.	$.5 \times 10^6$	500,000
k.	18×10^{-3}	.018
l.	12.5×10^3	12,500
m.	23×10^{-6}	.000023
n.	2.22×10^{-3}	.00222
o.	7.895×10^2	789.5
p.	4.11×10^{-3}	.00411
q.	3.365×10^1	33.65
r.	7.5×10^{-2}	.075
s.	5.55×10^{-1}	.555
t.	9×10^{-4}	.0009

(continued)

Answer Key

Review Problems From Page 9

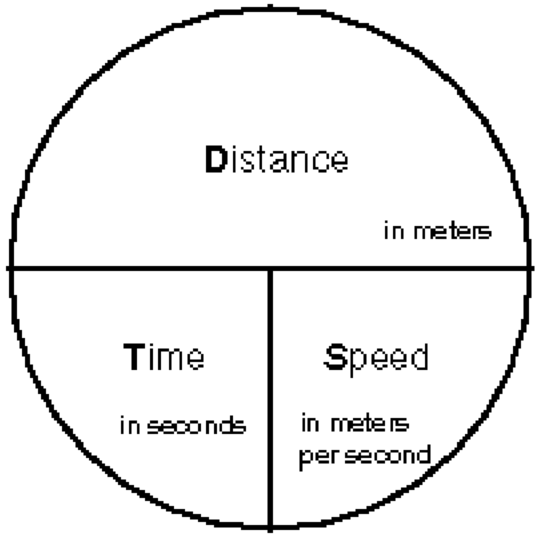
1. Express the following numbers in powers of 10.

Example:

	900	9×10^{2}
a.	320	3.2×10^{2}
b.	400,000	4×10^{5}
c.	1,000,000	1×10^{6}
d.	1,200	1.2×10^{3}
e.	1,200,000	1.2×10^{6}
f.	47,000	4.7×10^{4}
g.	.004	4×10^{-3}
h.	.000012	1.2×10^{-5}
i.	.001	1×10^{-3}
j.	.028	2.8×10^{-2}
k.	12,500	1.25×10^{4}
l.	3,000	3×10^{3}
m.	.000024	2.4×10^{-5}
n.	.975	9.75×10^{-1}
o.	.000342	3.42×10^{-4}
p.	.01	1×10^{-2}
q.	364	3.64×10^{2}
r.	875	8.75×10^{2}
s.	87.5	8.75×10^{1}
t.	.0987	9.87×10^{-2}

(continued)

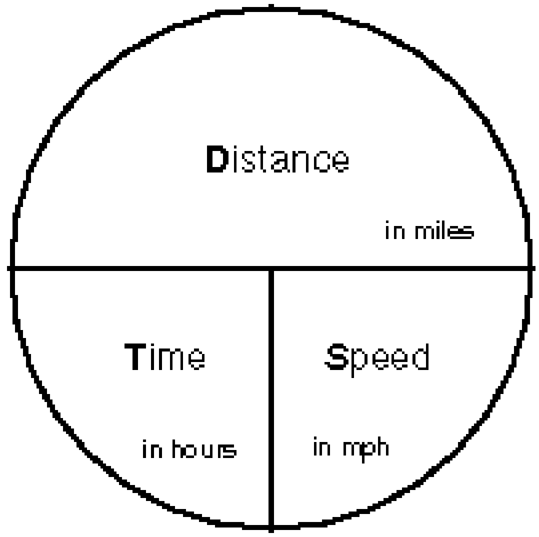
Practice Problems *(continued)*



D = 1.75 meters S = 1.32 mps T = _______seconds	D = 2155 meters S = _______mps T = 37.5 seconds	D = _______meters D = _______kmeters S = 75 mps T = 198.5 seconds
D = 62.7 meters S = 253 mps T = _______sec T = _______msec	D = 12.34 meters S = _______mps S = _______kmps T = 27.12 µsec	D = _______meters D = _______millimeters S = 100 mps T = 2218.5 µsec
D = 8.88 meters S = .250 mps T = _______sec T = _______msec	D = 2.47 meters S = _______mps S = _______millimps T = 3.1 msec	D = _______meters D = _______kmeters S = 12.25 mps T = 3222 msec

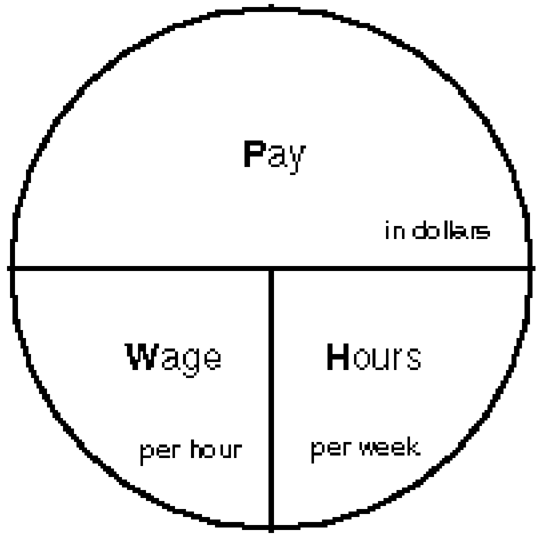
Reminder: µsec = microseconds
msec = milliseconds
kmeters = kilometers

Practice Problems *(continued)*



D = 1750 miles S = 55 mph T = _______hours	D = 2309 miles S = _______mph T = 37.5 hours	D = _______miles S = 66 mph T = 18.75 hours
D = 627 miles S = 22.25 mph T = _______hours	D = 1234 miles S = _______mph T = 27.12 hours	D = _______miles S = 48 mph T = 18.5 hours
D = 888 miles S = 88.8 mph T = _______hours	D = 247 miles S = _______mph T = 3.1 hours	D = _______miles S = 72 mph T = 32 hours

Practice Problems



P = $ 500 H = 40 hours W = $ _______	P = $ 432 H = _______hours W = $ 13.50	P = $ _______ H = 38 hours W = $ 11.50
P = $ 213.75 H = 28.5 hours W = $_______	P = $ 231 H = _______hours W = $ 5.50	P = $ _______ H = 51.9 hours W = $ 4.25
P = $ 415.19 H = 22.75 hours W = $ _______	P = $ 198.88 H = _______hours W = $ 9.25	P = $ _______ H = 19.25 hours W = $ 7.90

Rounding

Rounding is the approximation of a value to a specified number of decimal places, or significant digits.

For our purposes at electronics school, we will round to three digits.

A rounded number is a number that results from dropping the determined least significant digits, and if the dropped digit is 5 or greater, increasing the preceeding digit by 1.

For example; we know Pi to be 3.1415927.

If we were to round Pi to 3 digits, we would have 3.14.

Calculate the answer for the two problems below, and round the answer to 3 digits.

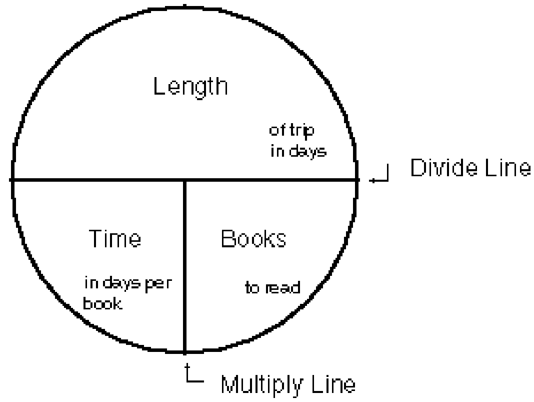
1. 125 µsec x .98 sec = __________ milliseconds

2. 18.5 milligrams + .144 grams = __________ milligrams

Complete the problems on the following pages, solving for the unknown and round to three digits if necessary.

(continued)

Solving for the Unknown Quantity *(continued)*



Using the above chart, we can calculate for any of the unknown variable if we know the other two.

In the first instance, we wanted to know how many books we would need for the trip.

To use a chart of this type, cover the unknown quantity (what we are trying to find) with your finger or thumb. What is left showing is our equation.

In our example, books is the unknown quantity, covering books shows that we would divide Length by Time to give us Books.

Let's say we had 15 books, and we wanted to know if this would be enough for a 90 day patrol.

So now Length is what we want to know. We will have to multiply.

Covering Length shows the equation now to be;

```
     15 (Books we have to read)
x     5 (Time to read a book)
--------------------------------
     75 days
```

We have enough books to last us 75 days, not enough for a 90 day patrol. Better head for the bookstore.

This type of chart is used in conjunction with Ohms' Law.

Ohms' Law describes the relationships between voltage, current, and resistance. By knowing how to use a chart of this type, any unknown can be found.

(continued)

Solving for the Unknown Quantity

Another important aspect of electronic mathematics is being able to solve for the unknown quantity.

In performing the previous calculations, you saw how different units of measure are related, the meter and the kilometer for instance.

When solving for an unknown, we can use the known quantities to find the one we are looking for.

We have all done this type of math without giving a second thought.

For example, I know it takes me 5 days to read an average length paperback book of 400 pages.

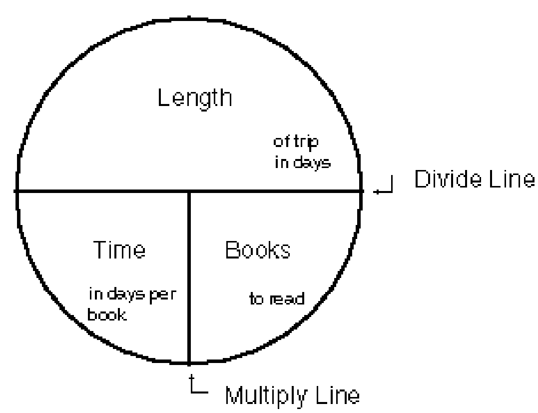
If I am going underway for an 8 week patrol, how many books would I need to bring along for the trip?

	8 weeks		56 days
x	7 days per week	÷	5 days per book
	56 days		11.2 books

8 weeks is a total of 56 days and 5 goes into 56 11.2 times.

So I would need to bring 11 or 12 books to read on the trip.

To make our calculations easier to visualize, we can use a chart as illustrated below.



(continued)

Review Problems *(continued)*

Convert the quantities listed below.

Example:

	1000 milliseconds =	1	second
a.	30 milliliters =	____________	liters
b.	3800 meters =	____________	kilometers
c.	490 microseconds =	____________	seconds
d.	7.5 grams =	____________	milligrams
e.	.55 kilometers =	____________	meters
f.	2.88 liters =	____________	milliliters
g.	4567 nanoseconds =	____________	microseconds
h.	3.42 millimeters =	____________	meters
i.	9876 milligrams =	____________	grams
j.	6.25 seconds =	____________	microseconds

(continued)

Review Problems *(continued)*

2. Convert the following powers of 10 to conventional numbers.

Example:

6.8×10^{3} 6800

a. 9.9×10^{3} ____________

b. 10^{5} ____________

c. 3.64×10^{2} ____________

d. 10^{-4} ____________

e. 2.81×10^{-3} ____________

f. 6.3×10^{-4} ____________

g. 65.1×10^{-6} ____________

h. 3×10^{3} ____________

i. 2.5×10^{9} ____________

j. $.5 \times 10^{6}$ ____________

k. 18×10^{-3} ____________

l. 12.5×10^{3} ____________

m. 23×10^{-6} ____________

n. 2.22×10^{-3} ____________

o. 7.895×10^{2} ____________

p. 4.11×10^{-3} ____________

q. 3.365×10^{1} ____________

r. 7.5×10^{-2} ____________

s. 5.55×10^{-1} ____________

t. 9×10^{-4} ____________

(continued)

Review Problems

1. Express the following numbers in powers of 10.

Example:

900 $\underline{\quad 9 \times 10^2 \quad\quad\quad}$

a. 320 ____________________

b. 400,000 ____________________

c. 1,000,000 ____________________

d. 1,200 ____________________

e. 1,200,000 ____________________

f. 47,000 ____________________

g. .004 ____________________

h. .000012 ____________________

i. .001 ____________________

j. .028 ____________________

k. 12,500 ____________________

l. 3,000 ____________________

m. .000024 ____________________

n. .975 ____________________

o. .000342 ____________________

p. .01 ____________________

q. 364 ____________________

r. 875 ____________________

s. 87.5 ____________________

t. .0987 ____________________

(continued)

Conversion Between Units *(continued)*

NOTE

Going from micro to milli is going from a small unit to a larger one. When converting from a large unit to a smaller one, the decimal point is shifted to the right.

It is important to become familiar with converting from one unit to another. A technical manual for a piece of electronic equipment may list a resistor as 2.2kΩ. When the technician orders a replacement resistor, it may be listed as 2200 ohms. The ohm (Ω) being the base unit of measure for resistance.

The technician must make the conversion to obtain the resistor with the correct value.

Scientific Calculators

The conversions previously discussed can be performed on paper or in some cases, your head.Using a scientific calculator will greatly simplify the task of working with these numbers, and performing calculations.

A scientific calculator that will suffice must have the RECIPRICOL and EXPONENT keys. A standard scientific calculator is all that is required. It is not necessary to purchase a high cost model, unless you choose to do so.

Every calculator varies in how to perform the various functions it is capable of doing. It is important you understand how to perform the functions outlined in this handout on your calculator.

Use your calculator, if necessary, to perform the following problems.

(continued)

Metric Prefixes and Engineering Notation *(continued)*

The prefixes and their symbols commonly used in engineering notation when working with electronics are shown in the table below.

Also shown are the relationships of the prefix to the base unit.

Notice that adjacent prefixes are related by factors of 1000, that is to say prefixes are either 1000 times as large or 1/1000 as large as their neighbor.

Metric Prefix	Symbol	Base 10 Number	Power of 10
Giga	G	1,000,000,000	10^{9}
Mega	M	1,000,000	10^{6}
kilo	k	1,000	10^{3}
Base Unit		1	10^{0}
Milli	m	.001	10^{-3}
Micro	µ	.000001	10^{-6}
Nano	n	.000000001	10^{-9}
Pico	p	.000000000001	10^{-12}

Conversion Between Units

Multiple and submultiple units are designated by adding the appropriate prefix to the base unit.

Now, 110,000 amperes can be expressed as 110 kiloamperes (kA).

.0000001 amperes can be written as .1 microamperes (µA).

Some other examples of conversion between units are;

2.5 meters	=	2500 millimeters
.083 seconds	=	83 milliseconds
2.2 kilometers	=	2200 meters

Notice that in all the above examples the conversion is made by moving the decimal point either three places or multiples of three places.

(continued)

Metric Prefixes and Engineering Notation

In electronic applications, the base unit of a quantity may seem to be very large or in some cases, very small.

For example, in solid state devices, technicians work with current levels of less than .0000001 amperes. Some manufacturing plants may work with current in excess of 110,000 amperes. The ampere (amp) being the base unit of measure for current.

Although these numbers could be shortened by expressing them in powers of 10, they would still be very long when spoken.

For example, 1.1×10^5 would be spoken as "one point one times ten to the fifth amperes".

To avoid such long expressions, scientists and technicians use engineering notation and metric prefixes to indicate units that are smaller or larger than the base unit.

Recall from page 1 of the handout that;

2.0×10^{-6} (scientific notation), was the same as

.000002 seconds (conventional notation)

The same number in Engineering Expression would be;

2 μseconds

Or 2 microseconds were we to say it. Engineering Expression is used in electronics daily almost without realizing it. Technicians generally always tend to shorten the quantities they are working with to their shortest means of expression.

The coefficient in engineering notation is usually between 1 and 999.

(continued)

Positive Exponents *(continued)*

A number can be converted to powers of 10 by making the exponent (power) equal to the number of places you move the the decimal point.

Two examples;

2100 can be expressed as 2.1×10^{3}

105,000 can be written 1.05×10^{5}

Notice that in scientific notation it is conventional to move the decimal so that there is only one digit to the left of it. The number multiplied by the power of 10 is called the coefficient.

In the examples above, 1.05 and 2.1 are the coefficients.

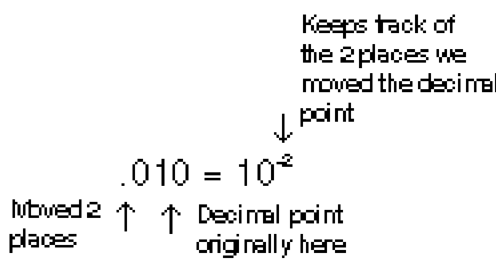
Negative Exponents

Numbers smaller than 1 are expressed in powers of 10 with negative exponents.

The negative exponent tells you how many times 1 is to be divided by 10. For example, 10^{-2} means that 1 will be divided by 10 twice.

$1 \div 10 \div 10 = .01$

When the exponent (power) is negative, move the decimal to the left. To convert 10^{-2}, just write a 1 and move the decimal two places to the left.



Doing this results in .01, which is equal to 10^{-2}.

To convert to a negative power of 10, just move the decimal to the right of the first digit larger than zero.

The negative exponent equals the number of places you moved the decimal place. For example;

.000000054 is equal to 5.4×10^{-8}.

(continued)

Positive Exponents

Numbers larger than 1 are expressed in powers of 10 with positive exponents.

The positive exponent tells you how many times 1 or a number is to be multiplied by 10.

For example, 5×10^2 means that 5 will be multiplied by 10 twice:

$$5 \times 10 \times 10 = 500$$

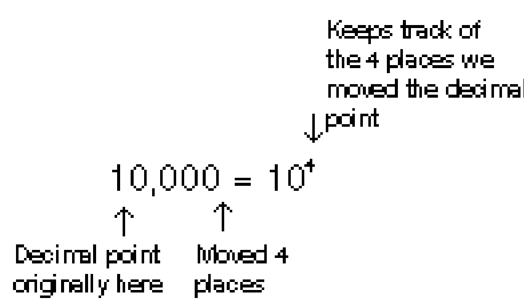
Ten to the first power (10^1) would be $1 \times 10 = 10$. In the abscence of a number, the 1 x is understood.

Powers of ten and their base 10 equivalents which are commonly used in electronics are listed below.

Powers of 10	Number (Base 10 equivalent)
10^9	1,000,000,000
10^6	1,000,000
10^3	1,000
10^0	1
10^{-3}	.001
10^{-6}	.000001
10^{-9}	.000000001
10^{-12}	.000000000001

The power (exponent) of 10 tells you how many places to move the decimal point.

For example, 10^4 can be changed to a number without an exponent by writing a 1 and moving the decimal point four places to the right.



Thus, 10^4 is equal to 10,000.

(continued)

Introduction to Scientific Notation *(continued)*

For example; 2.3×10^6 is an approximation accurate to two significant figures of 2,345,678.

When two numbers are multiplied or divided in scientific notation, the decimal numbers are first multiplied or divided by each other. Then the powers of 10 are added (for multiplication), or subtracted (for division).

Finally, the product to quotient is reduced to standard form. That is, the decimal part of the expression should be at least 1 but less than 10.

For example; $3 \times 10^2 \times 7 \times 10^3 = 21 \times 10^5 = 2.1 \times 10^6$.

The following sections of this handout will go into more detail with exponents, and performing math using exponents.

(continued)

Introduction

This handout serves as an informational review of the powers of 10 and solving for the unknown.

Directions

Read through the following pages on the powers of 10 and scientific notation. Solve the problems as directed in the handout.

Introduction to Scientific Notation

In the field of electronics, technicians work with very large and very small numbers.

Very large or very small numbers are cumbersome to write in the conventional fashion. Scientific notation provides a shortcut for expressing extreme numerical values.

A number in scientific notation consists of a decimal number with a value of at least 1, but less than 10, followed by a power of 10. The decimal number indicates the first few digits of the actual value as it would be written in longhand, or conventional, form.

An example would be; 2.0×10^{-6} seconds

Longhand, or the conventional form of expressing numbers, is where the entire number is written.

The same number as above, written conventionally would be;

.000002 seconds

Another means of expression, known as Engineering Notation, is also commonly used. We will see this later in the handout.

Using scientific notation, the power of 10 gives the factor by which the decimal number is multiplied. The exponent is always an integer; it may be positive or negative.

The decimal part of a scientific notation expression may have any number of significant figures, depending on the accuracy needed.

(continued)

Mathematics Review

Purpose

This handout is intended to prepare you for the type of mathematics used here at "A" school.

There is not a math review in the course of instruction, so it it up to you to brush up on these skills.

A "Scientific" calculator will be a convenient aid in class for the calculation of the related formulas.

Scientific calculators are not provided by the school, but are permitted, and are encouraged for use in class.

Most calculators come with a guide book to assist you with the various functions. These calculators are available for $10-20 at drug and department stores.

This handout will be a good prepatory step towards making a smooth transition into "A" school and will benefit you throughout your career.

An answer key is provided at the end of the handout so you may check your work, and provide an indication that more review may or may not be needed.

(continued)